RMIT University

An International Perspective

Peeking Over the Horizon

MBAV Road Show

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CRC Construction Innovation

Introduction

- My time in the USA
  - Virginia Tech and the land grant mission
  - work with builders on the east coast
  - Work with US Dept of Housing and Urban Development
  - The PATH program
- Changes in the US construction industry in the period 1998-2005
  - Are they important for us here ?
  - Responses to change
  - New building methods
- Understanding the building process
  - Process research
  - Information use

US Building Industry (EAST COAST)

- Construction is an industry of last resort
  - Safety is a significant problem
  - Skill level of the workforce is diminishing and the workforce is
  - made up of unskilled immigrants
  - Very limited trade training
- Supervisors and skilled trades
  - Age of supervisors
  - Age of tradesmen
  - Background level

US Building Industry (EAST COAST)

- Zoning and land regulation in large centers means land acquisition is difficult
- Local code interpretation differences
  - Examples
  - Problems with inspectors
- Pressures to reduce delivery times
- Pressures on energy performance of housing from both a regulator and consumer perspective

The responses to the pressures

- Growth of companies
  - consolidation of companies around land contracts
- The skills shortage
  - NO REAL RESPONSE TO THIS
  - Increased OH&S regulation
  - A move to prefabrication and panelization
- Energy and housing performance
  - A change to designs, less glass, better insulation
  - New construction techniques, panelization, precast basements, ICFs

Building responses to pressures

- Industrialisation
  - Panelisation
  - Modularisation
  - Factory built systems
  - HUD – Code (trailer homes)
  - Information handling and process management

Panelisation

- The drivers for change
  - Builders having trouble sourcing skilled subcontractors
  - Believed to be more efficient
  - Leading players adopted the method
  - Ready network of suppliers of panels with engineering backup

Types of Panels

- Open Panels
- Closed Panels
  - SIPS
  - SIPS with windows
- Concrete Panels

Open Panels


PH RC 1/33

Closed Panels

- How SIPS are made
- Cut outs
- Windows
- Insulation values

Modular Housing

- Advantages

- It took approximately 6 hours to assemble this 3,200 Square Foot Home. Within 3 weeks the HVAC, plumbing connection, electrical connection, garage and miscellaneous site work was complete and the new owners moved into their new home. (from Hallmark Homes Website)

Setting the Modules

Setting the Modules

Setting the Modules

Setting the Modules

Setting the Modules

Setting the Modules

Building the Modules -Floor

Building the Modules-Walls

Building the Modules – On line

Building the Modules – Roof construction

Building the Modules – roof lifting

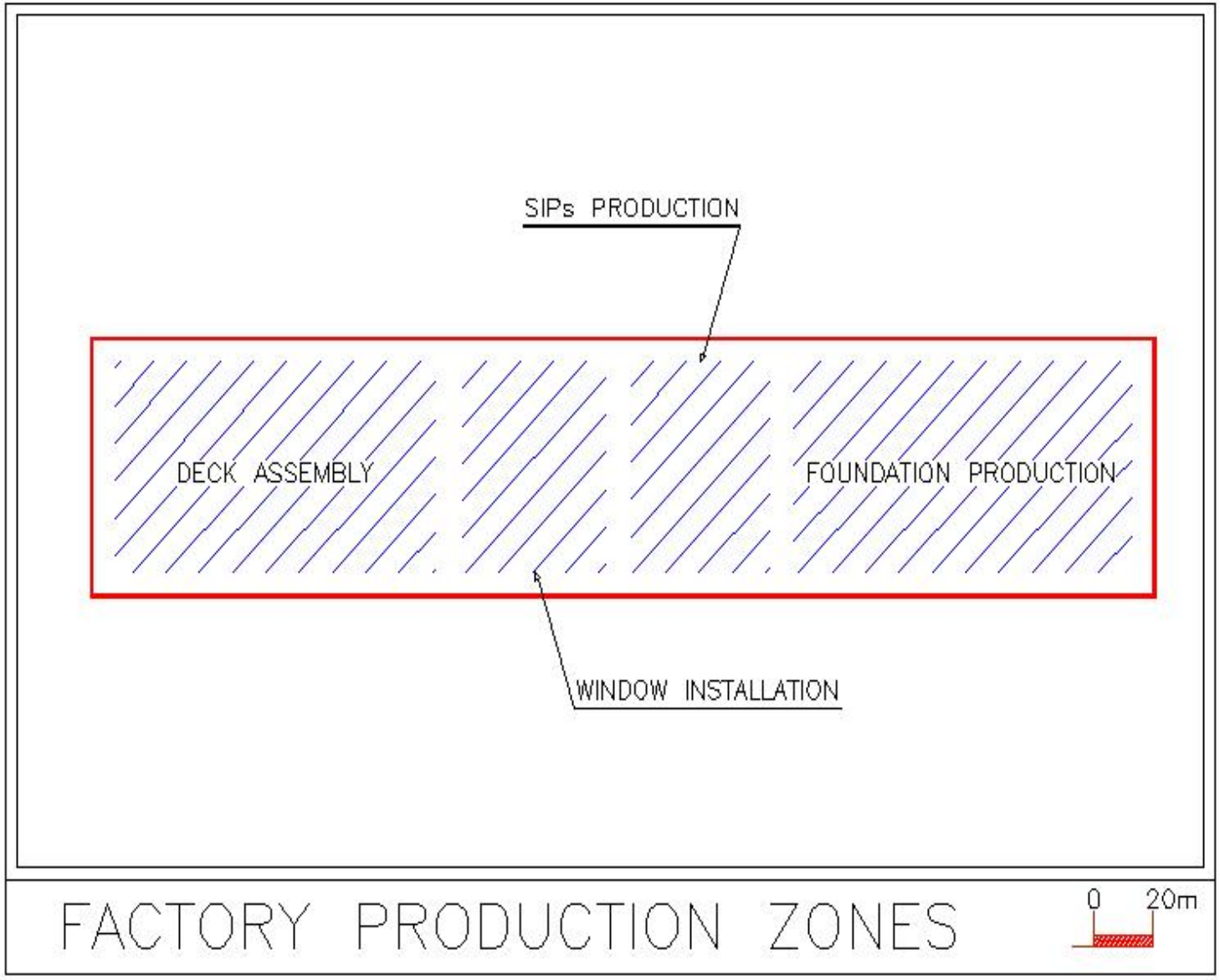
Building the Modules – roof installation

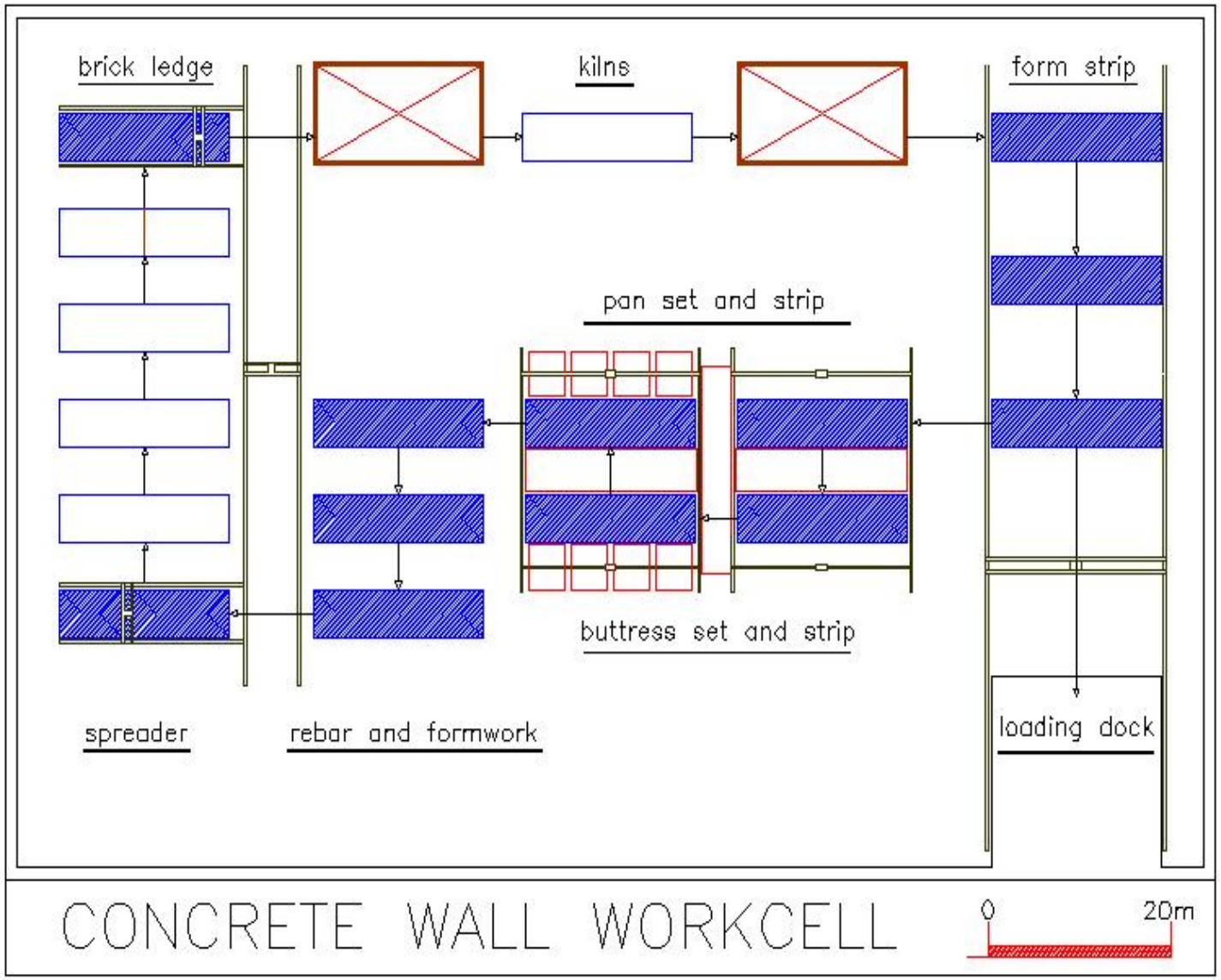
Building the Modules- roof test

Building the Modules – ready for transport

The New Factory Approach to Home Building –towards an integrated model

- The approach, the company, the investment
- Rationale for the approach
  - Quality of product – 40% better energy performance
  - Speed
  - Reliability and liability reduction
  - On site labor
  - Volume of production
- The beginnings of an industrialized approach


SIPs PRODUCTION
DECK ASSEMBLY
FOUNDATION PRODUCTION
WINDOW INSTALLATION
FACTORY PRODUCTION ZONES
0
20m



Place B

Place P

Panel Move

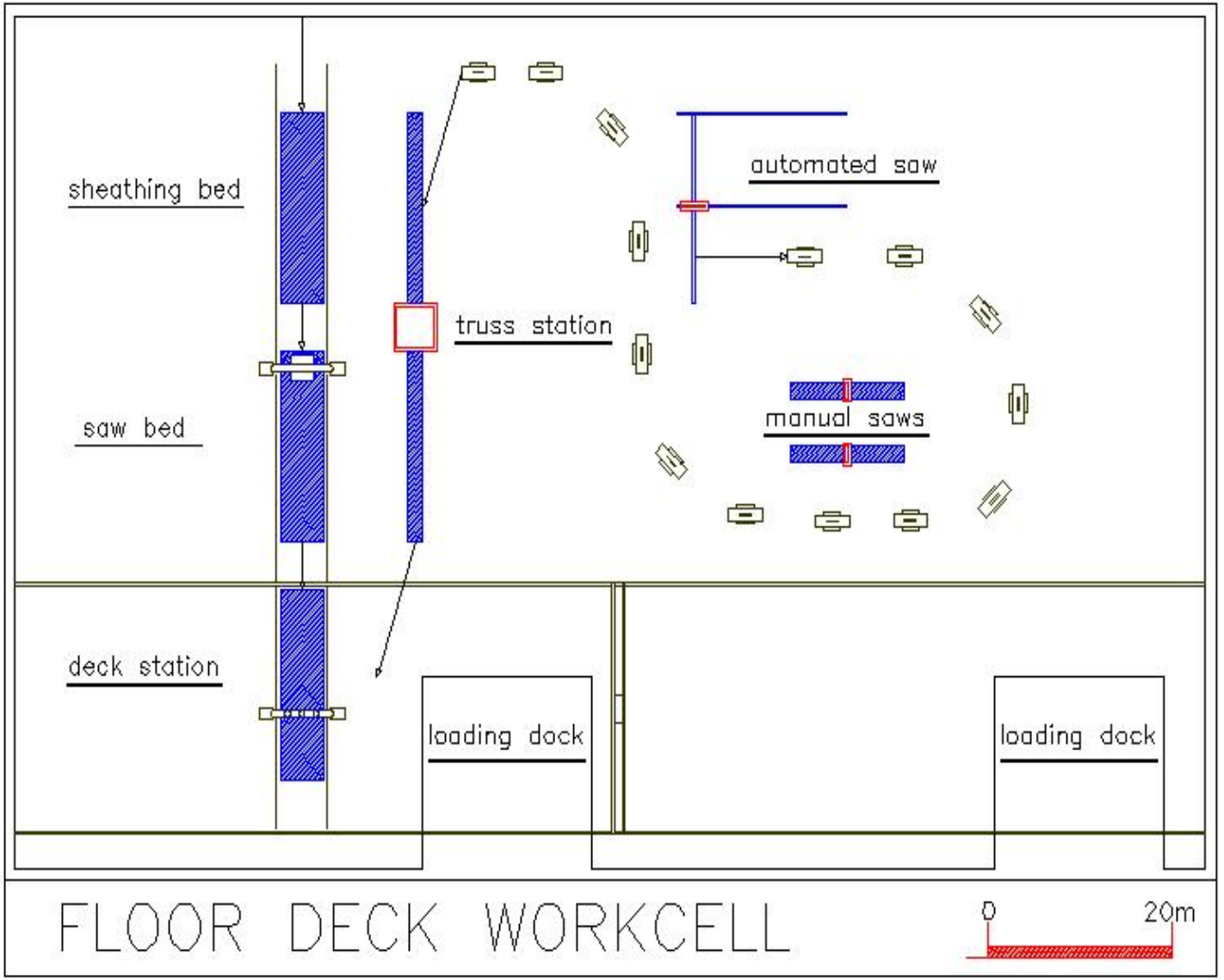
Conc. Place

To Kiln

To Load

Panel production line


PWI CARGO



Mat Q
Truss
Layout
Deck
Nail
Lift

Understanding the Construction Process

- 4D CAD
- Process modelling
- Virtual prototyping
- Information Integration

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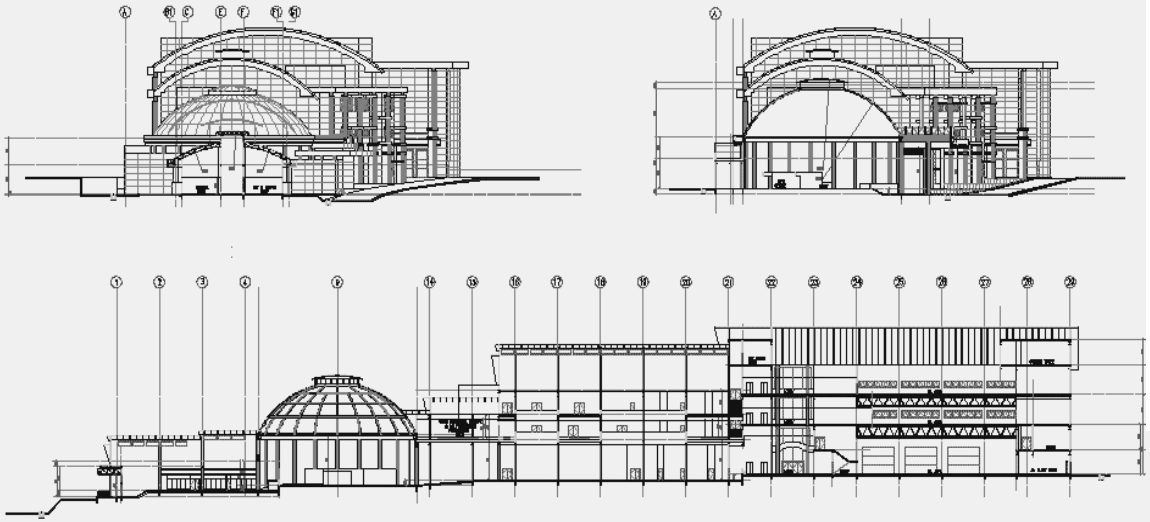
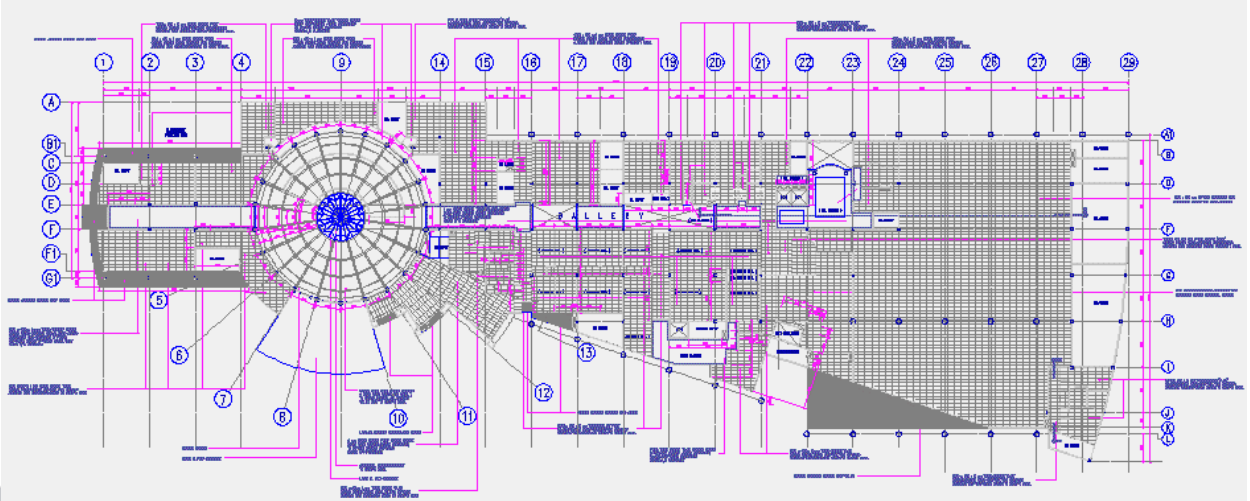


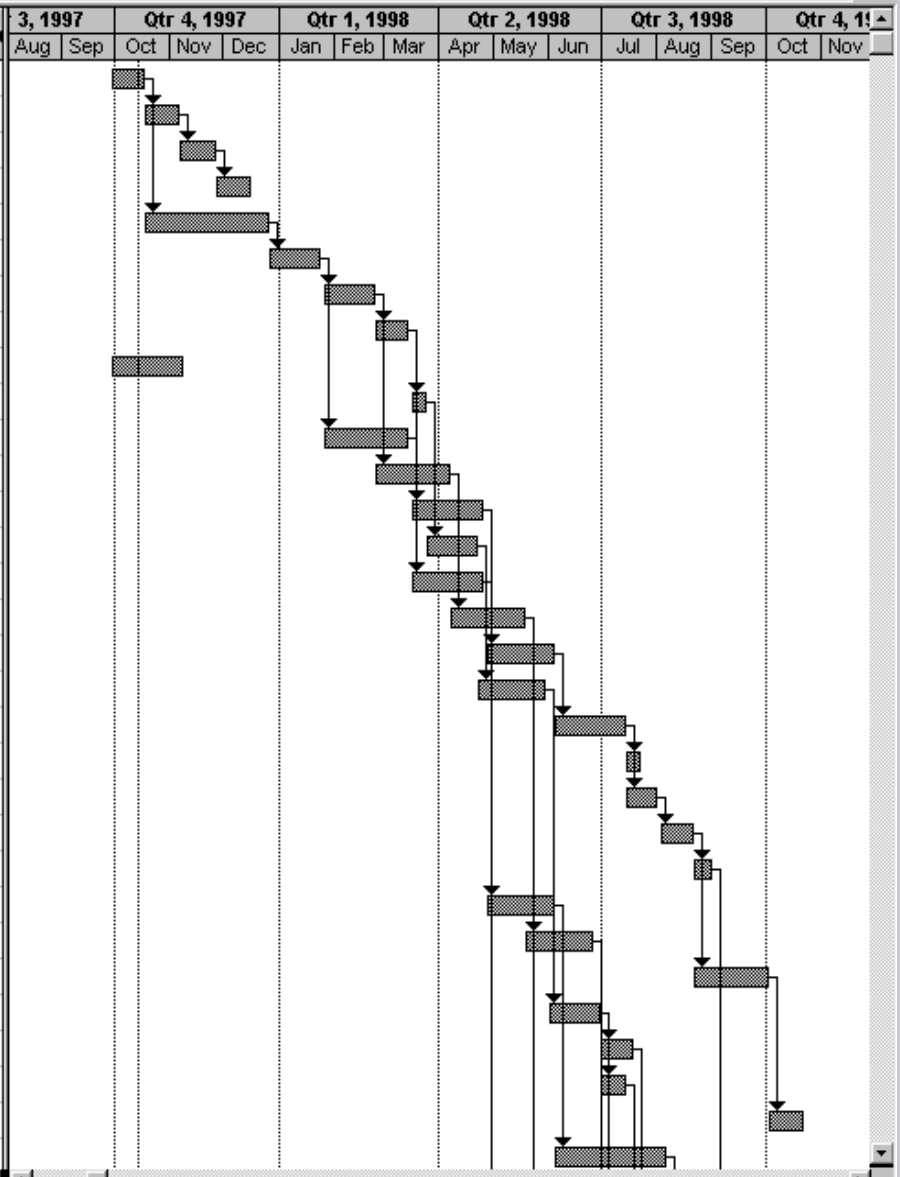


Microsoft Project - IBCSched

File Edit View Insert Format Tools Window Help

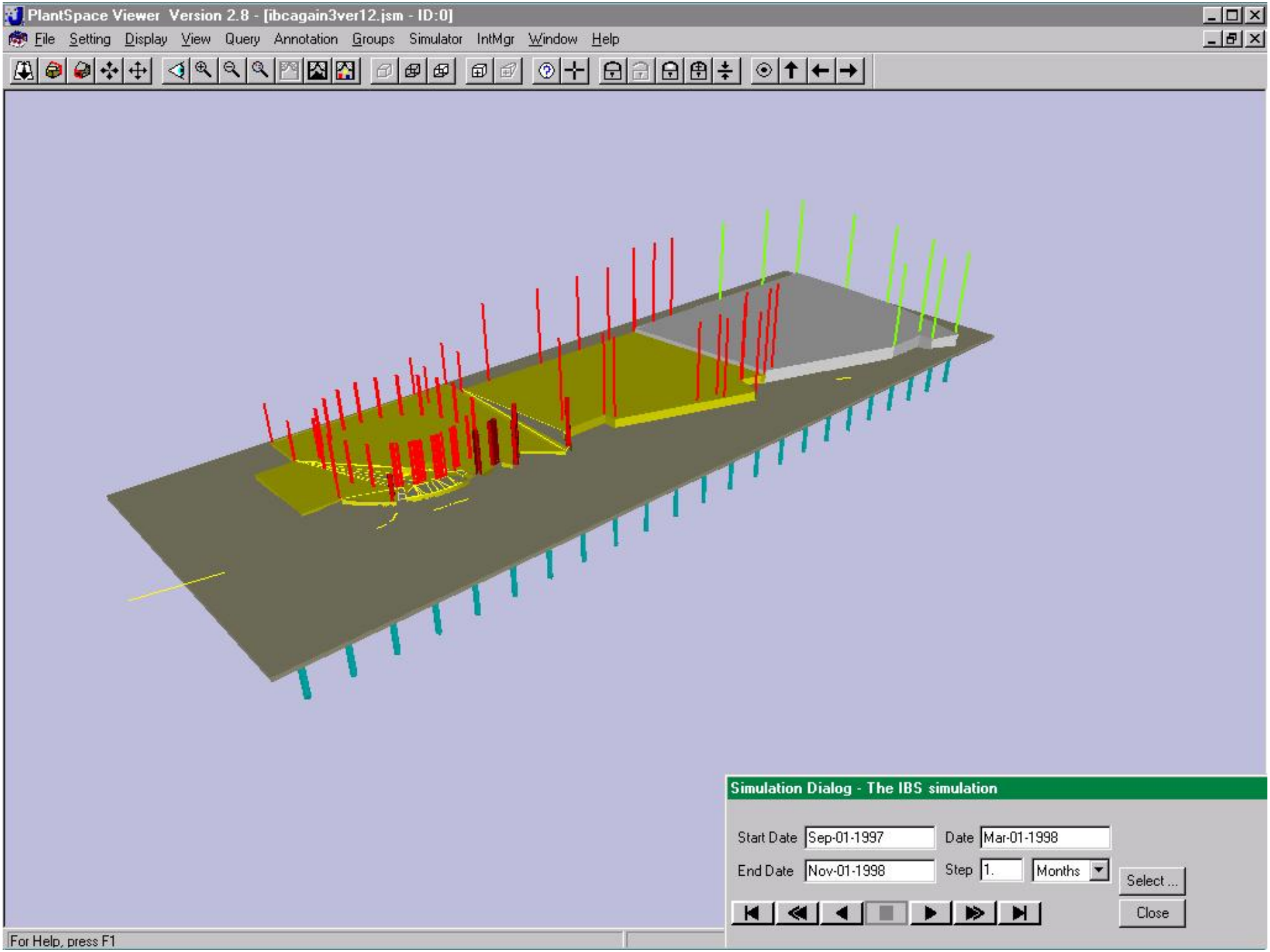
All Tasks | Arial | 10 | B I U

	Task Name	Duration	Start	Finish	Predecesso
1	Platform 1 piles	14d	Mon 9/29/97	Thu 10/16/97	
2	Platform 2 piles	14d	Fri 10/17/97	Wed 11/5/97	1
3	Platform 3 piles	14d	Thu 11/6/97	Tue 11/25/97	2
4	Platform 4 piles	14d	Wed 11/26/97	Mon 12/15/97	3
5	Raft	50d	Fri 10/17/97	Thu 12/25/97	1
6	Slab 3	21d	Fri 12/26/97	Fri 1/23/98	5
7	Slab 2	21d	Mon 1/26/98	Mon 2/23/98	6
8	Slab 1	14d	Tue 2/24/98	Fri 3/13/98	7
9	Drains	30d	Mon 9/29/97	Fri 11/7/97	
10	External stairs	7d	Mon 3/16/98	Tue 3/24/98	8
11	Platform 4 frames	35d	Mon 1/26/98	Fri 3/13/98	6
12	Platform 3 frames	30d	Tue 2/24/98	Mon 4/6/98	7
13	Platform 2 frames	30d	Mon 3/16/98	Fri 4/24/98	8
14	Platform 1 frames	20d	Wed 3/25/98	Tue 4/21/98	10
15	Platform 4 external wall	30d	Mon 3/16/98	Fri 4/24/98	11
16	Platform 3 external wall	30d	Tue 4/7/98	Mon 5/18/98	12
17	Platform 2 interior wall	28d	Mon 4/27/98	Wed 6/3/98	13
18	Platform 1 interior wall	28d	Wed 4/22/98	Fri 5/29/98	14
19	Dome structure	28d	Thu 6/4/98	Mon 7/13/98	17
20	Dome gutter	7d	Tue 7/14/98	Wed 7/22/98	19
21	Dome top structure	14d	Tue 7/14/98	Fri 7/31/98	19
22	Dome layer	14d	Mon 8/3/98	Thu 8/20/98	21
23	Dome top	7d	Fri 8/21/98	Mon 8/31/98	22
24	Platform 4 soffit	28d	Mon 4/27/98	Wed 6/3/98	15
25	Platform 3 soffit	28d	Tue 5/19/98	Thu 6/25/98	16
26	Platform 2 exterior wall	30d	Fri 8/21/98	Thu 10/1/98	22
27	Platform 1 exterior wall	21d	Mon 6/1/98	Mon 6/29/98	18
28	Windows	14d	Tue 6/30/98	Fri 7/17/98	27
29	Platform 1 soffit	10d	Tue 6/30/98	Mon 7/13/98	27
30	Platform 2 roof slab	14d	Fri 10/2/98	Wed 10/21/98	26
31	Platform 4 outer columns	45d	Thu 6/4/98	Wed 8/5/98	24



Ready

EXT CAPS NUM SCRL OVR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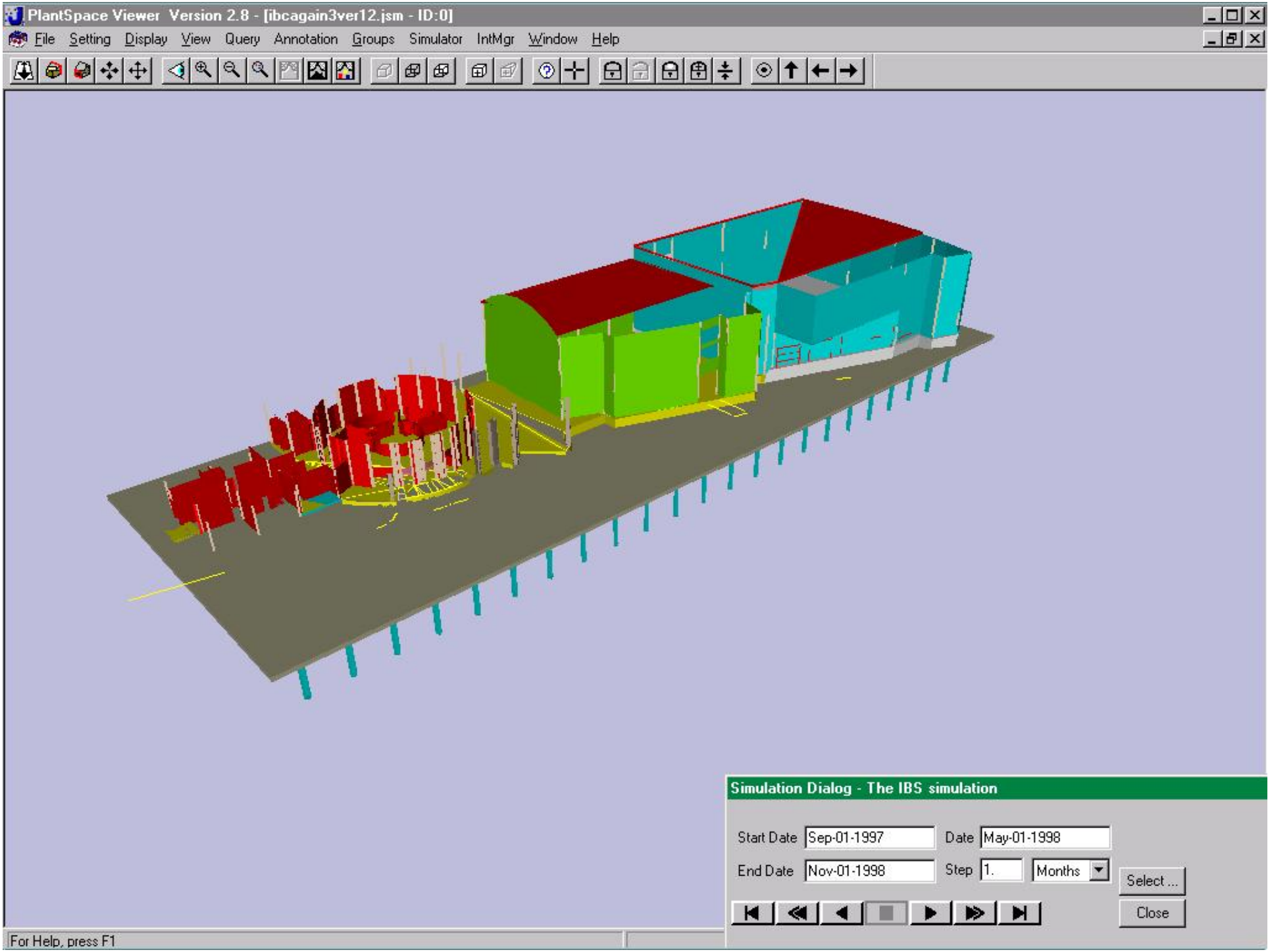
Simulation Dialog - The IBS simulation
Start Date Sep-01-1997
Date Mar-01-1998
End Date Nov-01-1998
Step 1.
Months
Select ...
Close
For Help, press F1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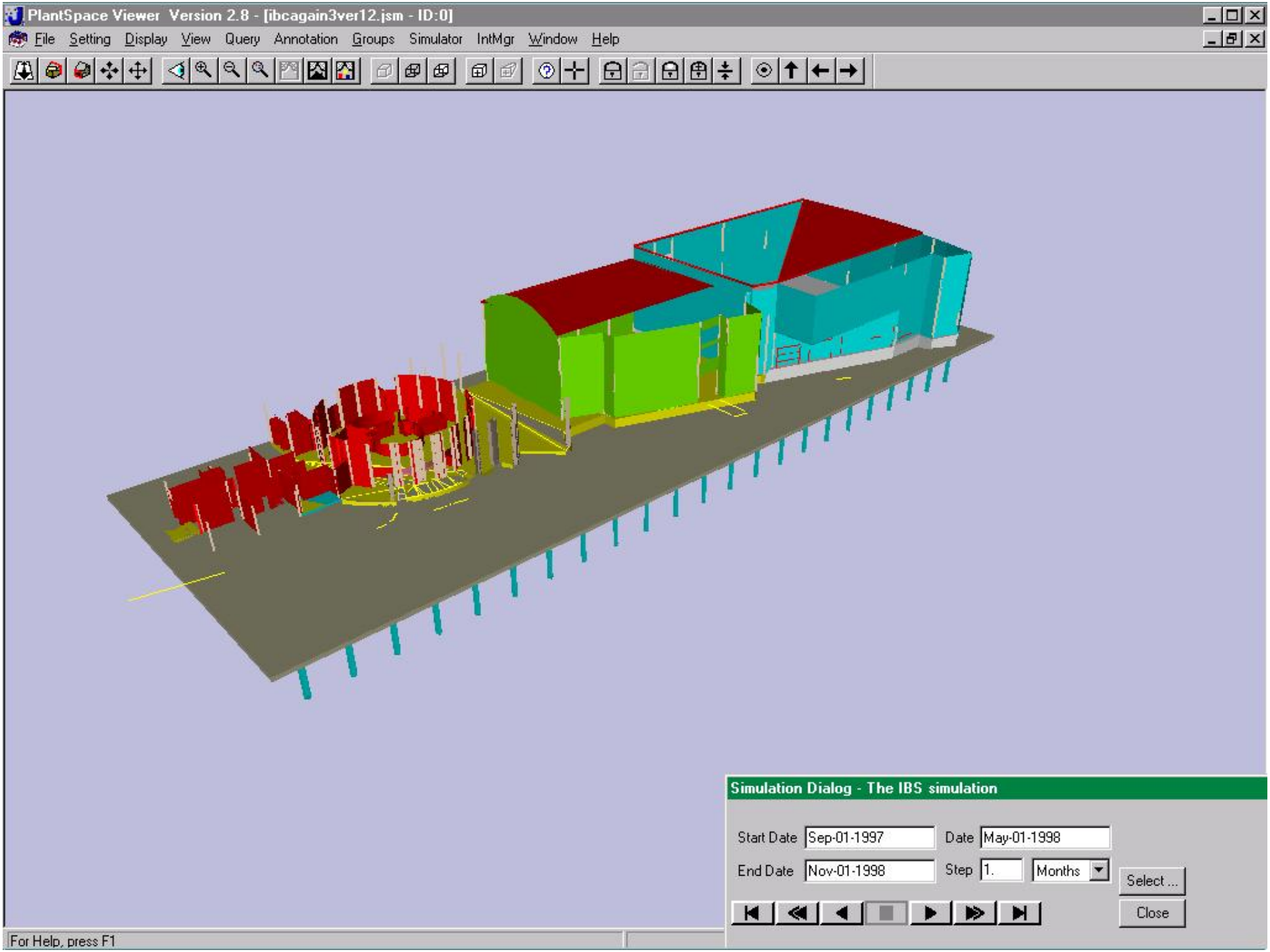
Simulation Dialog - The IBS simulation
Start Date Sep-01-1997
Date May-01-1998
End Date Nov-01-1998
Step 1.
Months
Select ...
Close
For Help, press F1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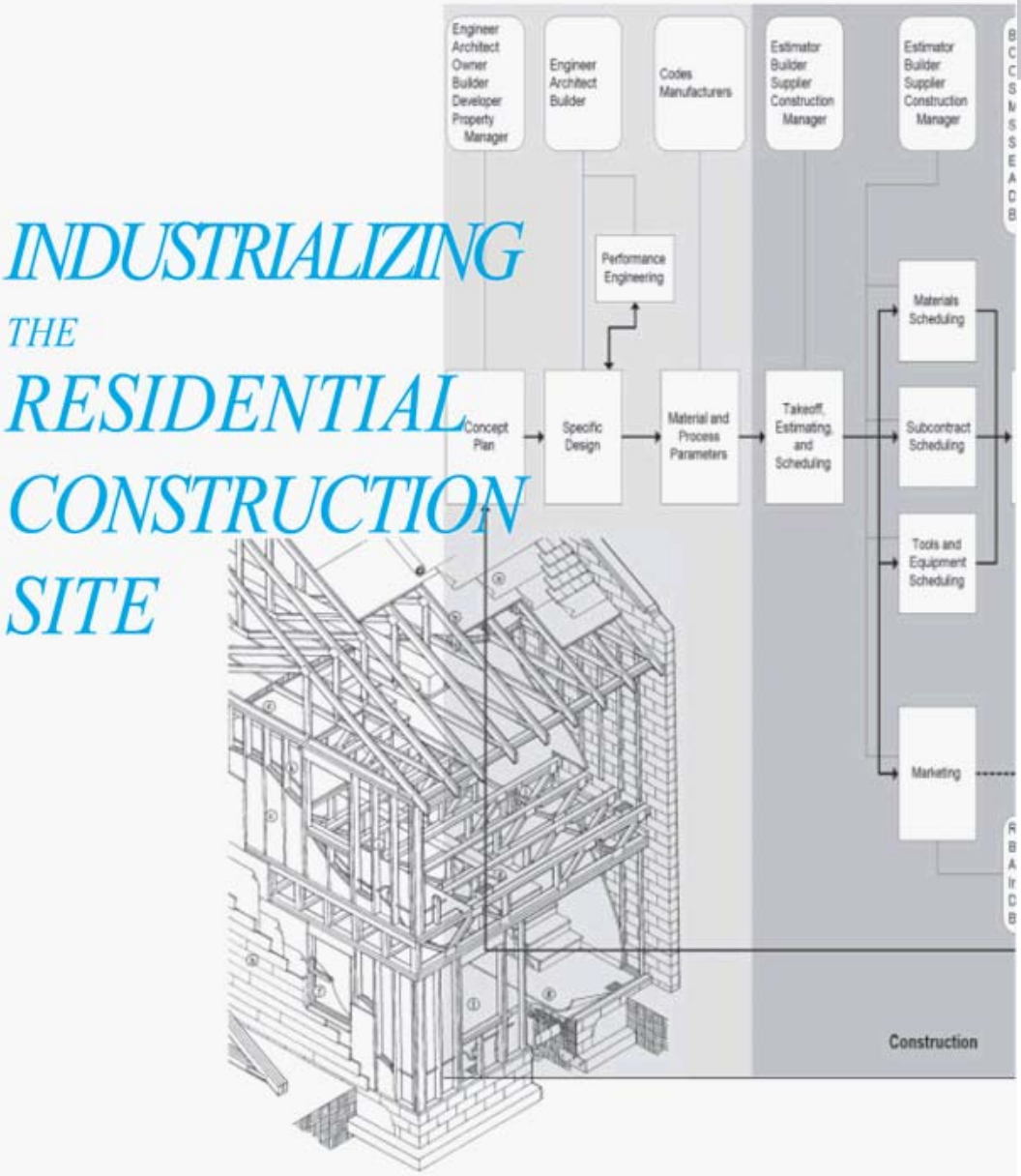
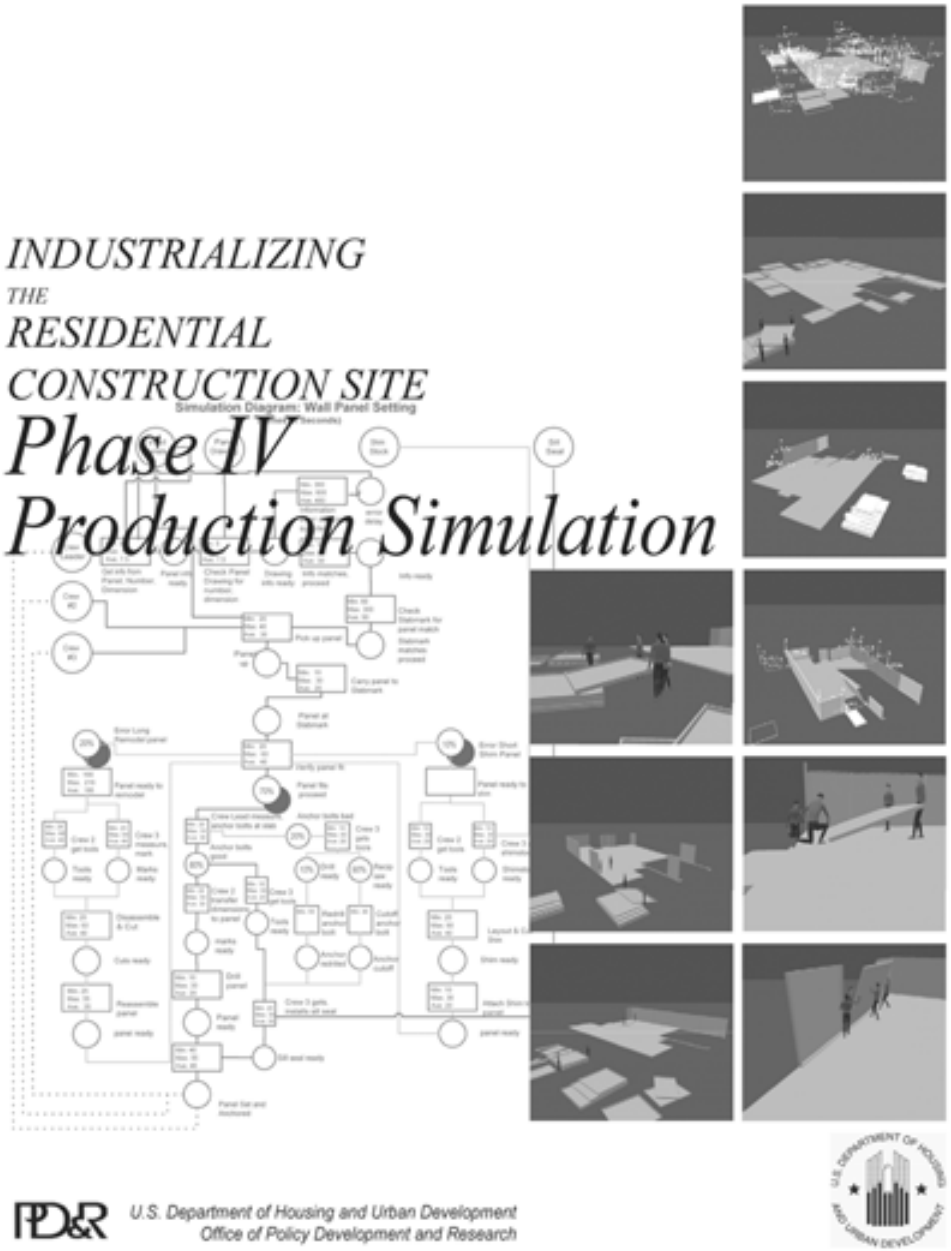


Phase I Overview and Integration

- Completed 2000
- Review of
- Robotics
- Manufactured Systems
- Historic Programs
- Digital Technology
  - •in manufacturing
  - • residential construction

Proposed five types of integration necessary to increase, productivity, performance, quality, value in residential construction:

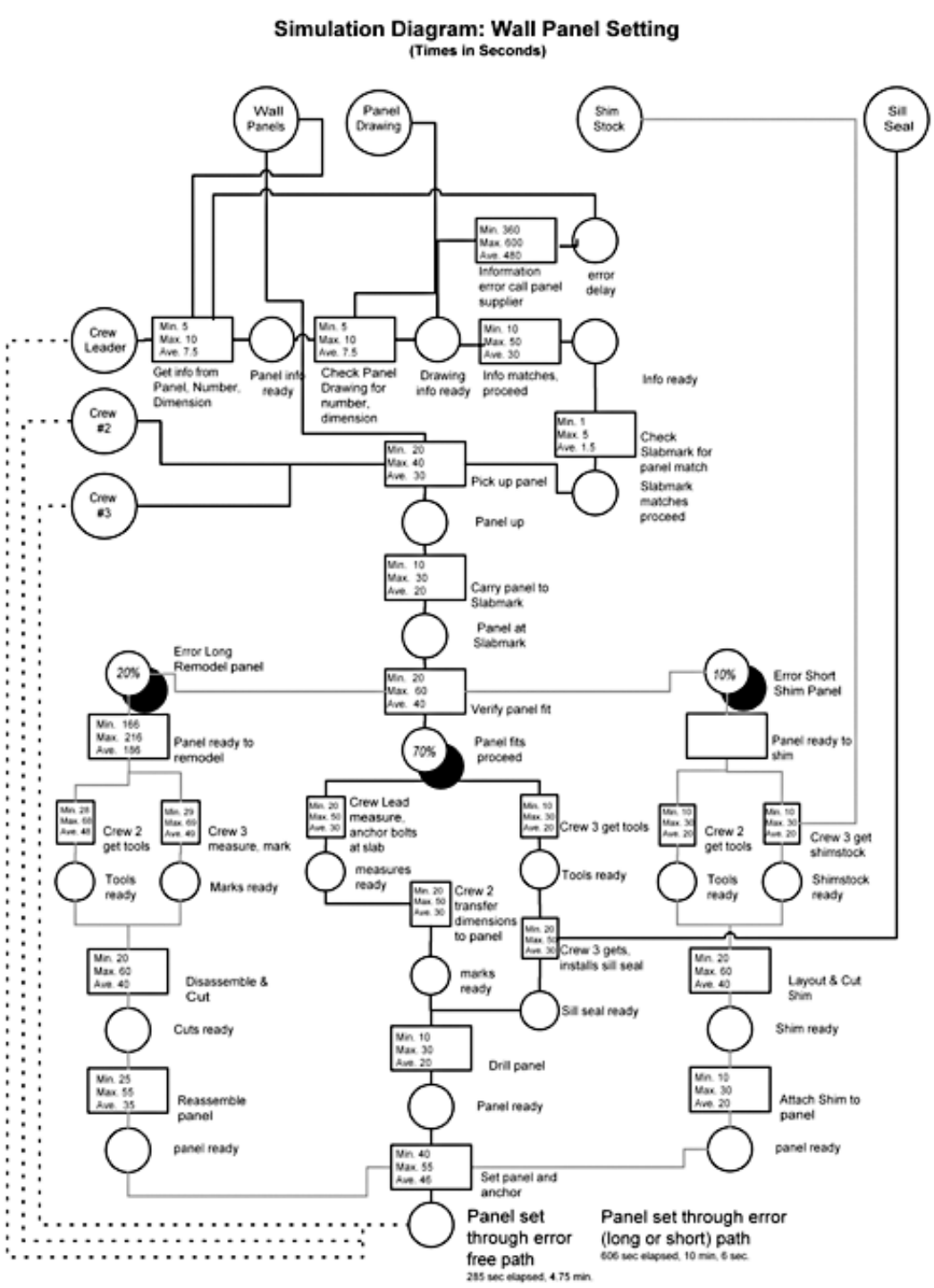
- information
- physical
- performance
- production
- operations

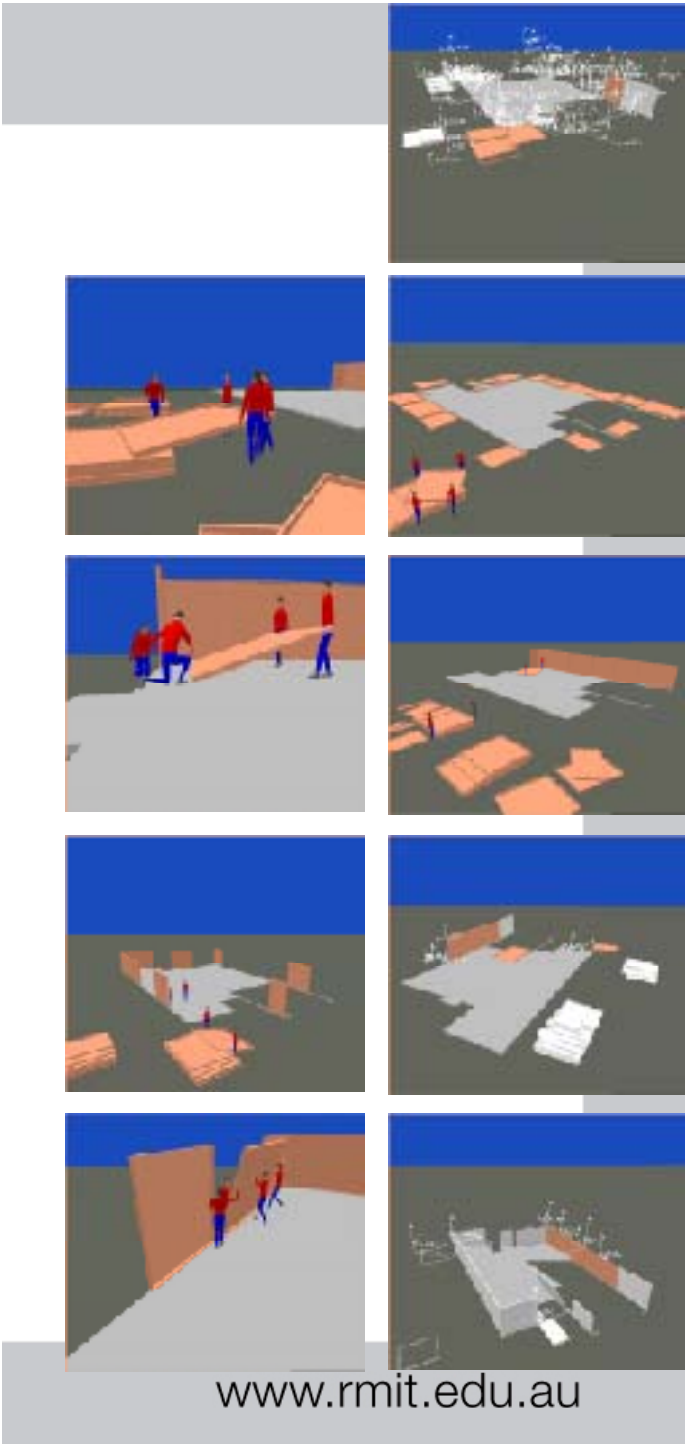


Phase IV Production Simulation

Evaluated viability of simulation methods for residential construction

- Graphical / Physics approach
- Numerical / Petri-Net approach


Simulation Diagram: Wall Panel Setting
(Times in Seconds)
Wall Panels
Panel Drawing
Shim Stock
Sill Seal
Min. 360
Max. 600
Ave. 480
Information error call panel supplier
error delay
Crew Leader
Min. 5
Max. 10
Ave. 7.5
Get info from Panel, Number, Dimension
Panel info ready
Min. 5
Max. 10
Ave. 7.5
Check Panel Drawing for number, dimension
Drawing info ready
Min. 10
Max. 50
Ave. 30
Info matches, proceed
Info ready
Crew #2
Min. 1
Max. 5
Ave. 1.5
Check Slabmark for panel match
Crew #3
Min. 20
Max. 40
Ave. 30
Pick up panel
Slabmark matches proceed
Panel up
Min. 10
Max. 30
Ave. 20
Carry panel to Slabmark
Panel at Slabmark
20%
Error Long Remodel panel
Min. 20
Max. 60
Ave. 40
Verify panel fit
10%
Error Short Shim Panel
Min. 166
Max. 216
Ave. 186
Panel ready to remodel
70%
Panel fits proceed
Panel ready to shim
Min. 28
Max. 68
Ave. 48
Crew 2 get tools
Crew 3 measure, mark
Min. 20
Max. 50
Ave. 30
Crew Lead measure, anchor bolts at slab
Min. 10
Max. 30
Ave. 20
Crew 3 get tools
Crew 2 get tools
Crew 3 get shimstock
Tools ready
Marks ready
measures ready
Min. 20
Max. 50
Ave. 30
Crew 2 transfer dimensions to panel
Tools ready
Shimstock ready
Min. 20
Max. 60
Ave. 40
Disassemble & Cut
marks ready
Crew 3 gets, installs sill seal
Sill seal ready
Min. 20
Max. 60
Ave. 40
Layout & Cut Shim
Cuts ready
Min. 10
Max. 30
Ave. 20
Drill panel
Shim ready
Min. 25
Max. 55
Ave. 35
Reassemble panel
Panel ready
Min. 10
Max. 30
Ave. 20
Attach Shim to panel
panel ready
Min. 40
Max. 55
Ave. 46
Set panel and anchor
Panel set through error free path
285 sec elapsed, 4.75 min.
Panel set through error (long or short) path
606 sec elapsed, 10 min, 6 sec.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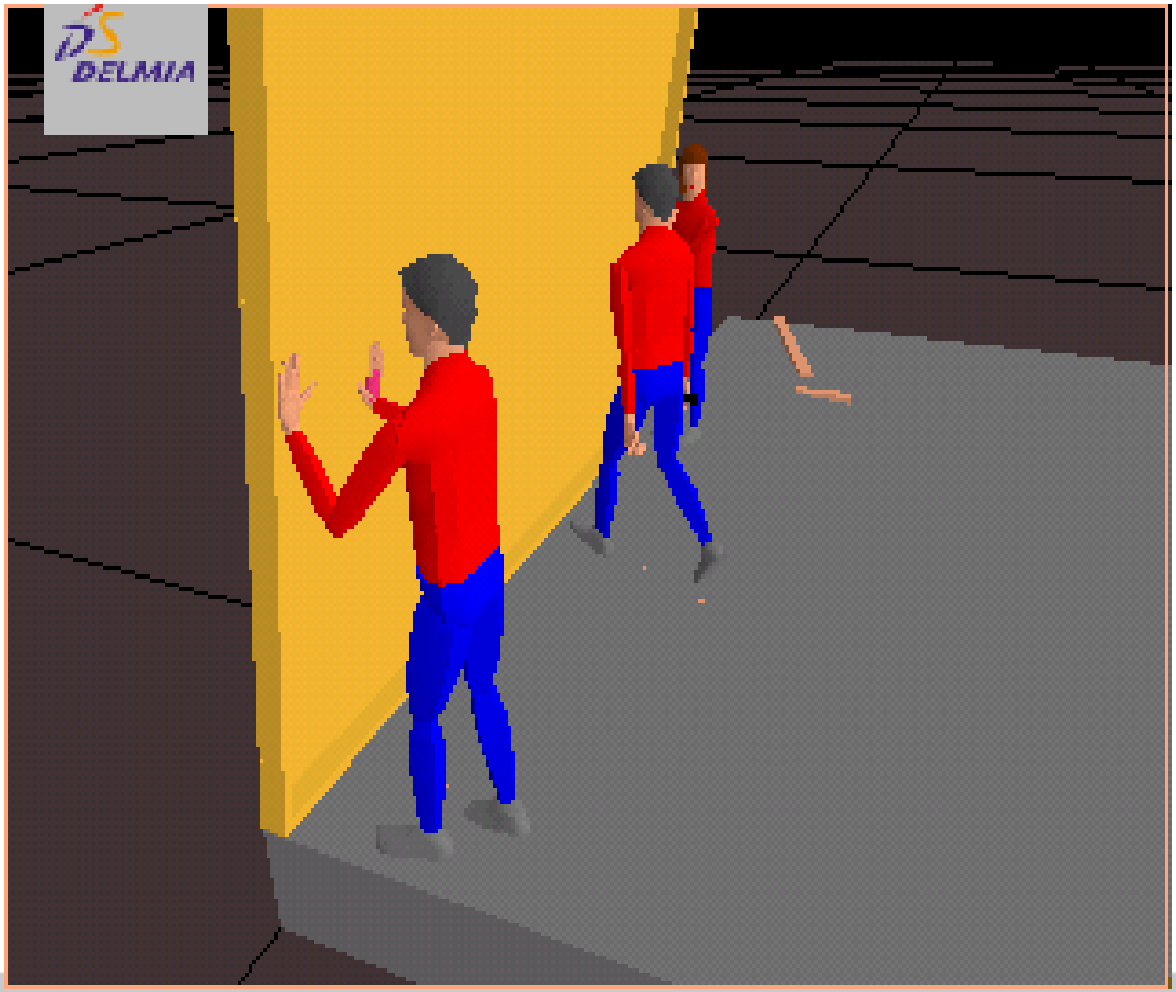
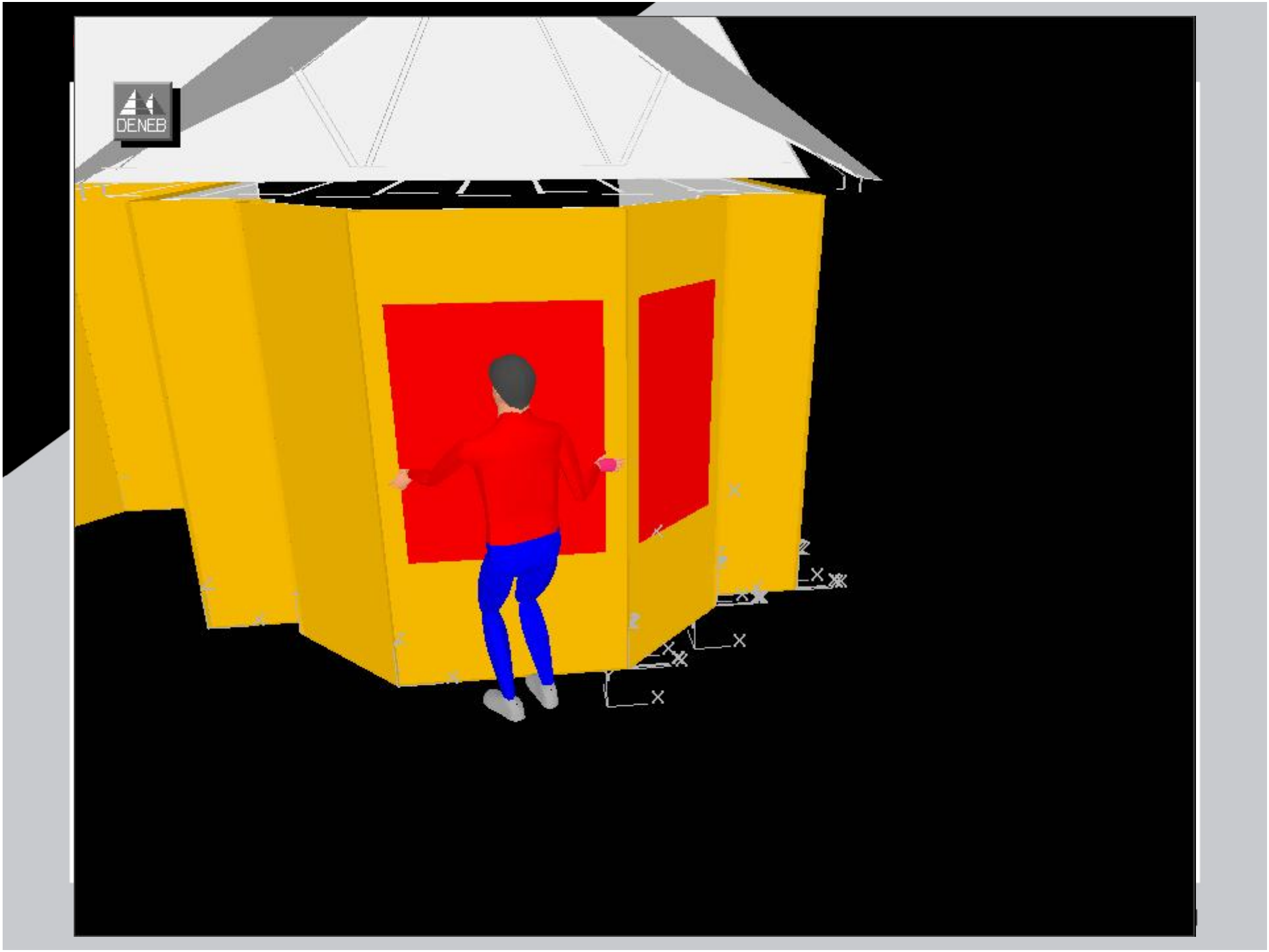
Phase Five - Virtual Prototyping

- Develop whole-process simulation
- Evaluate simulation's ability to predict disconnects / bottlenecks
- Develop intuitive connector between petri-net and graphical model
- Towards Total Building Model approach integrating process & engineering in design phase

Early Results

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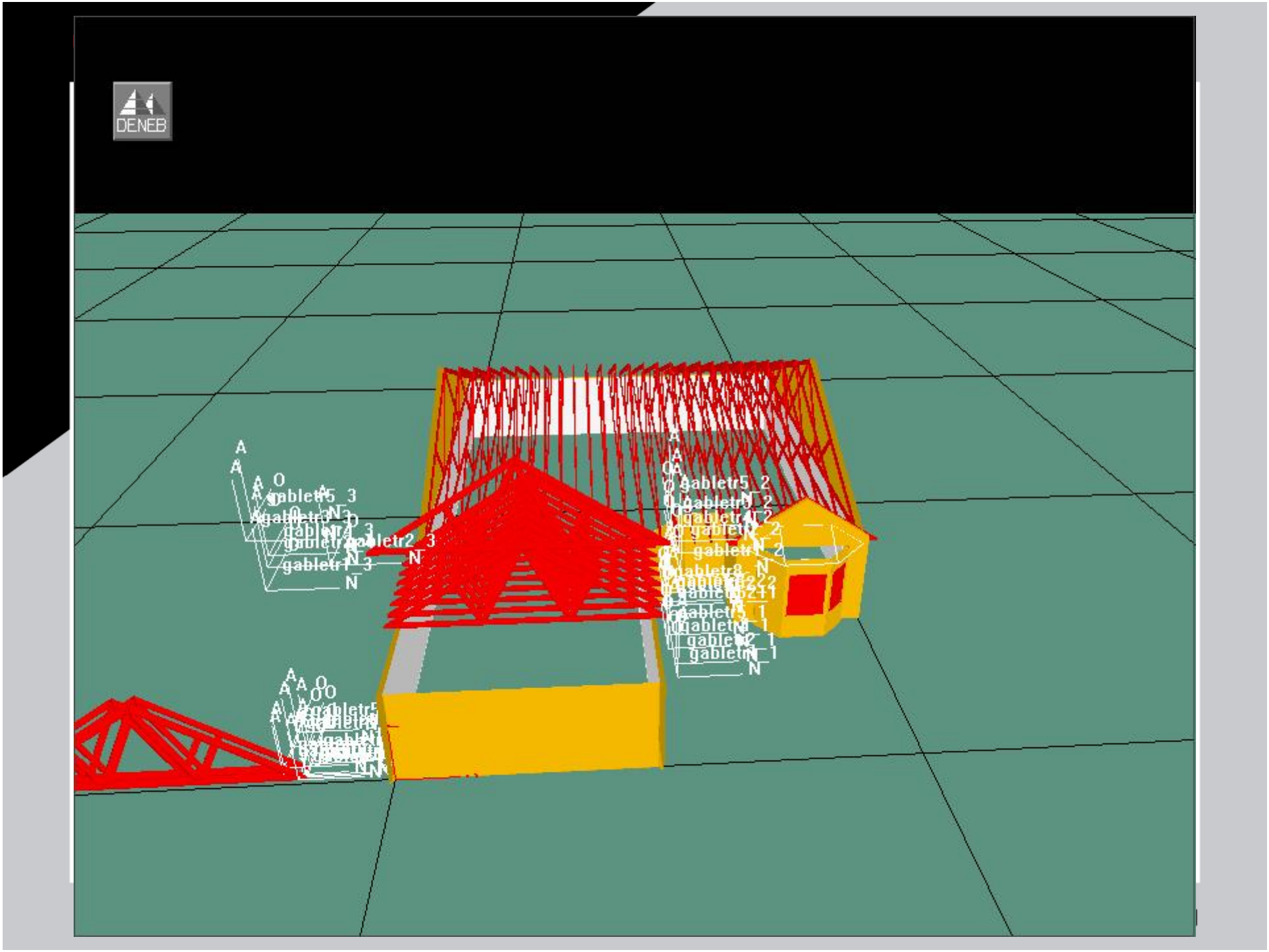
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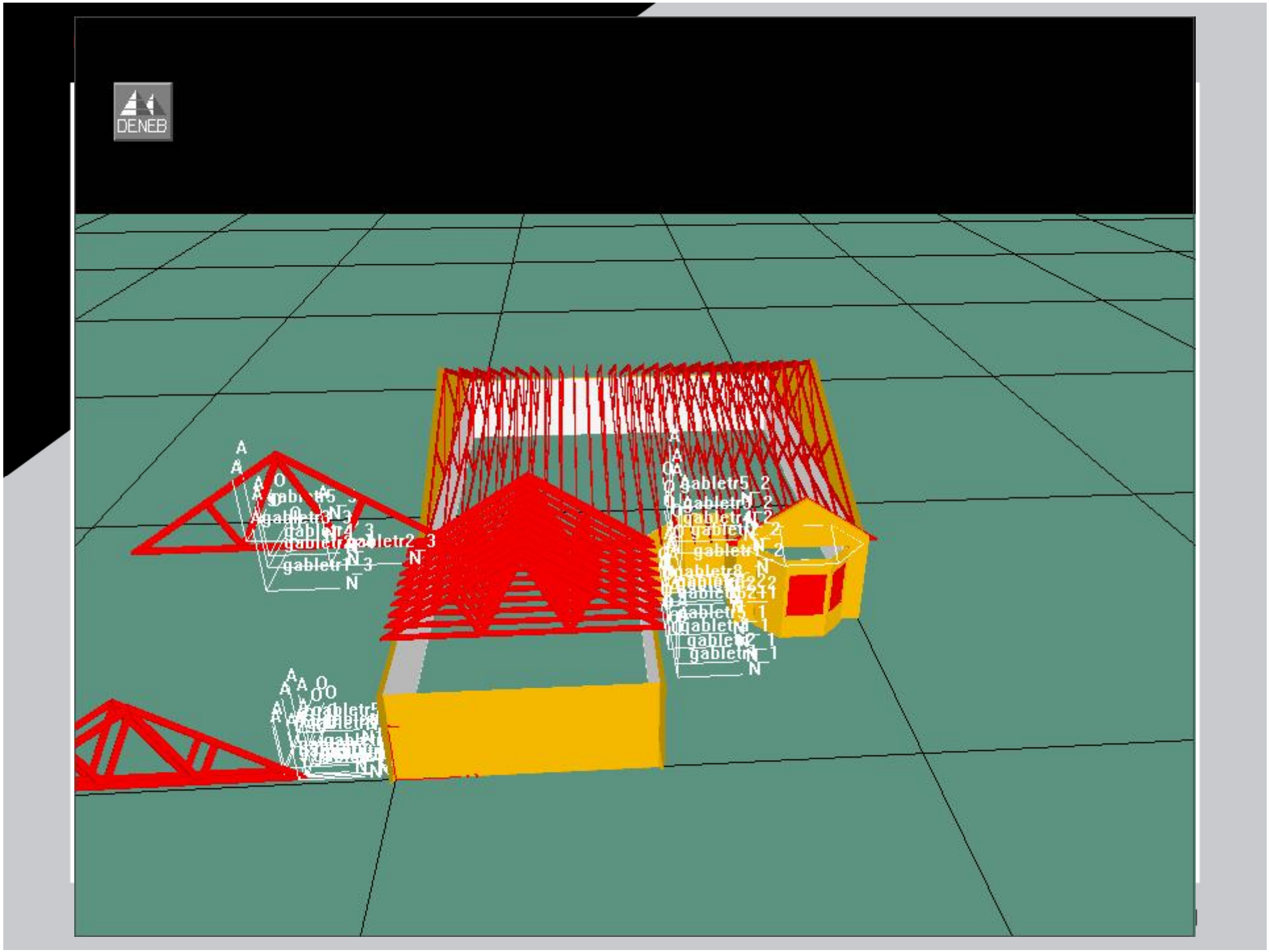
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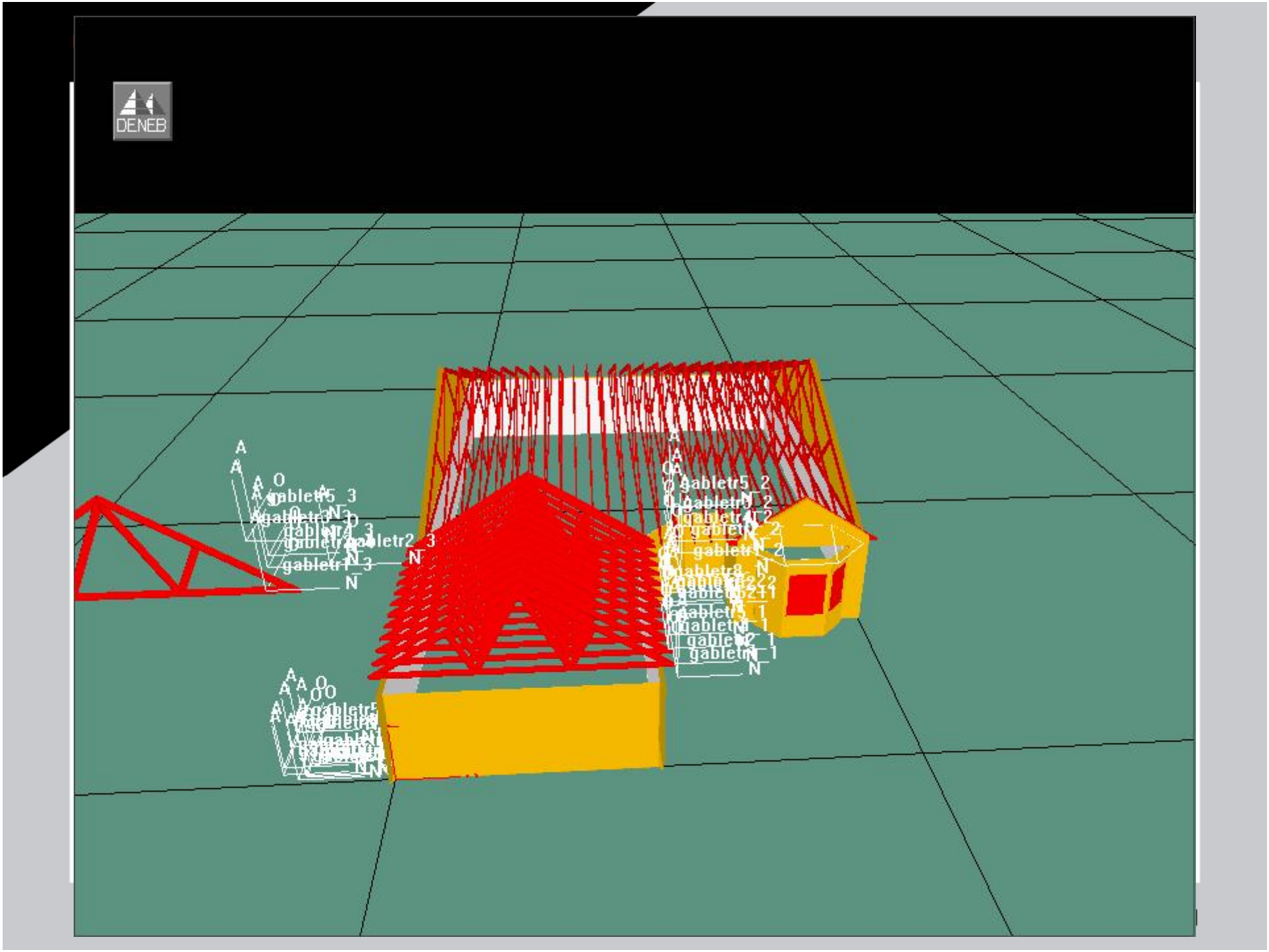
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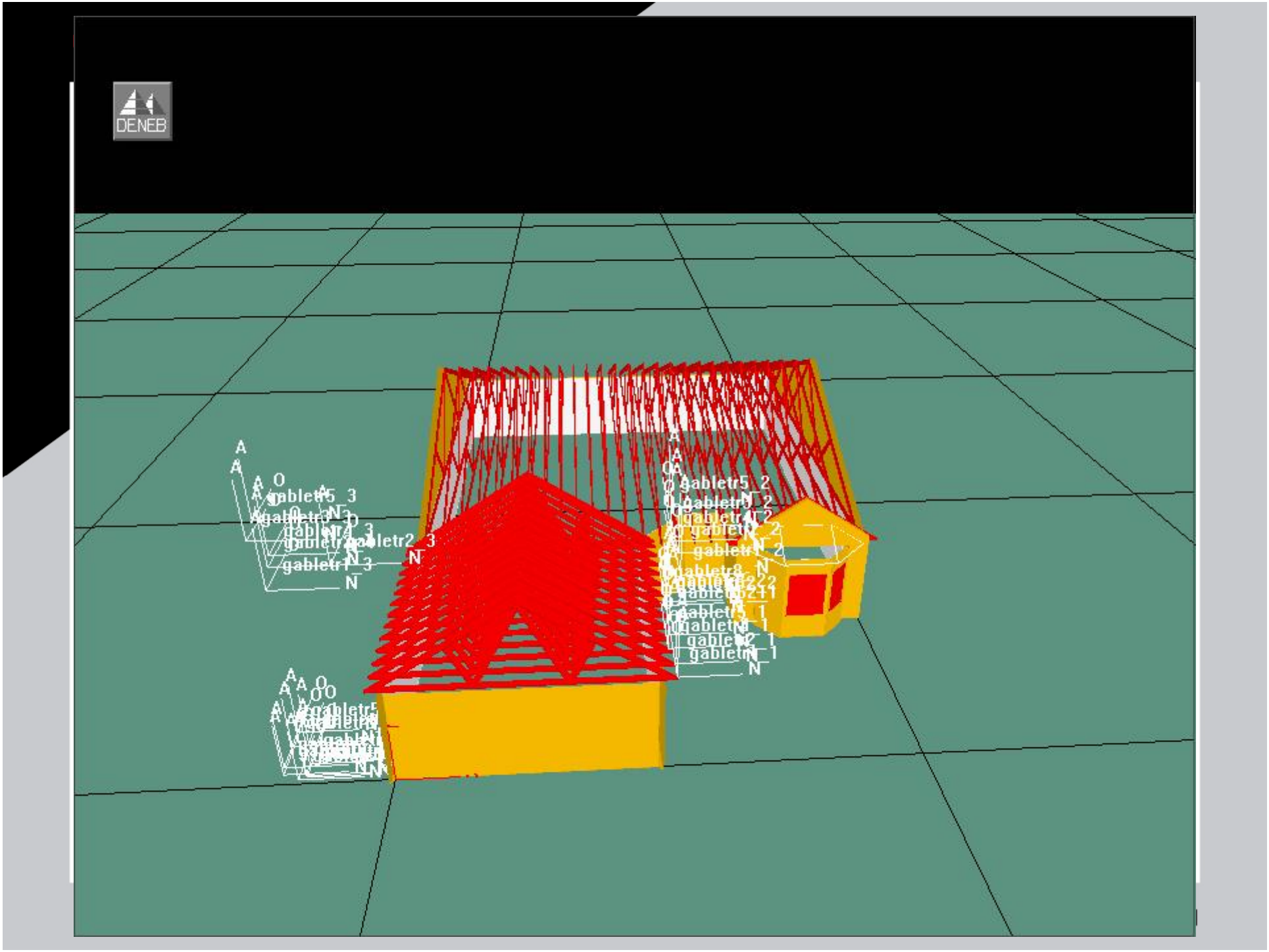
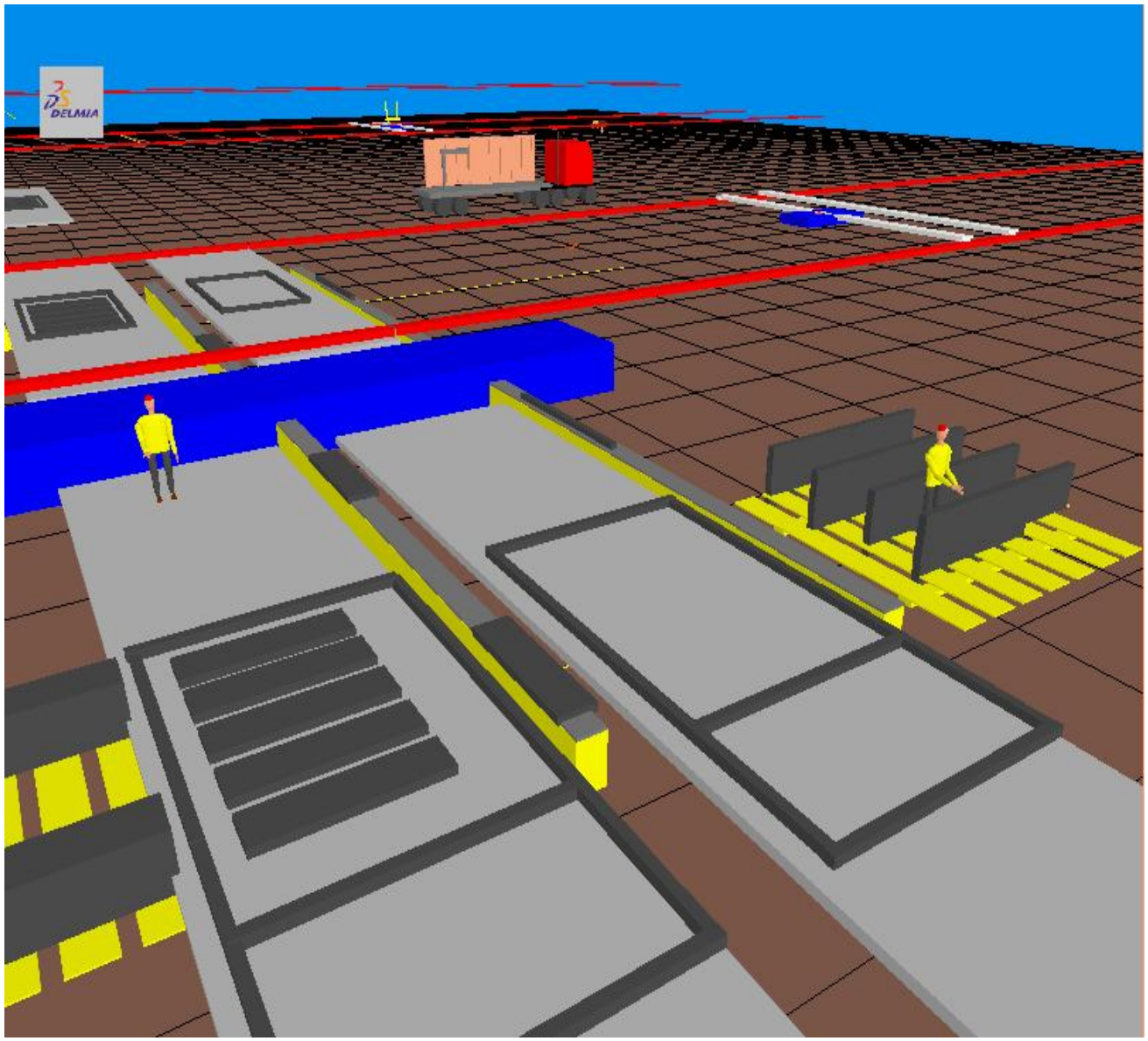

DENEB

Virtual Model

- To analyse
  - Production rates
  - Manpower requirements
  - Material flows
  - Ergonomics and safety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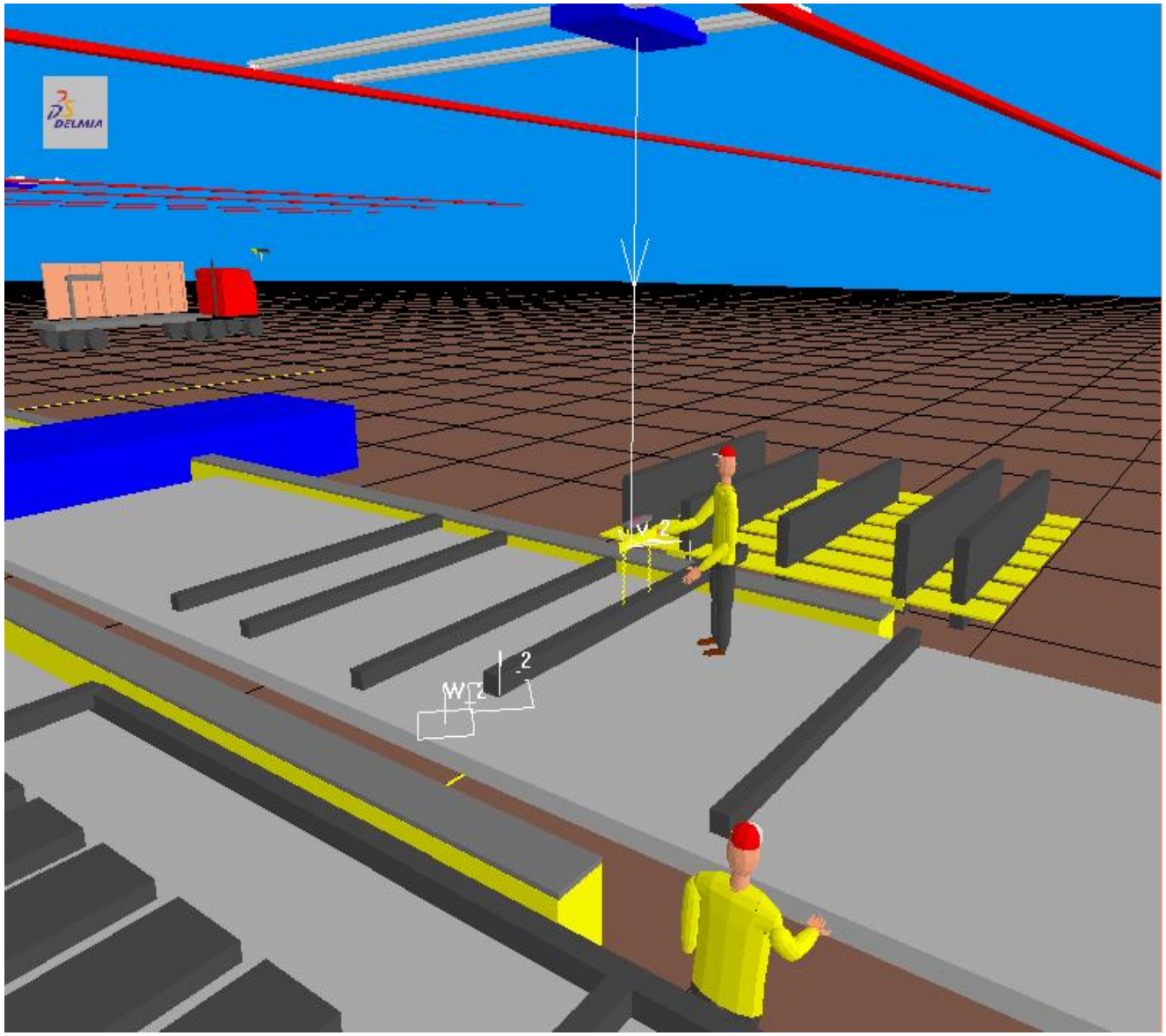
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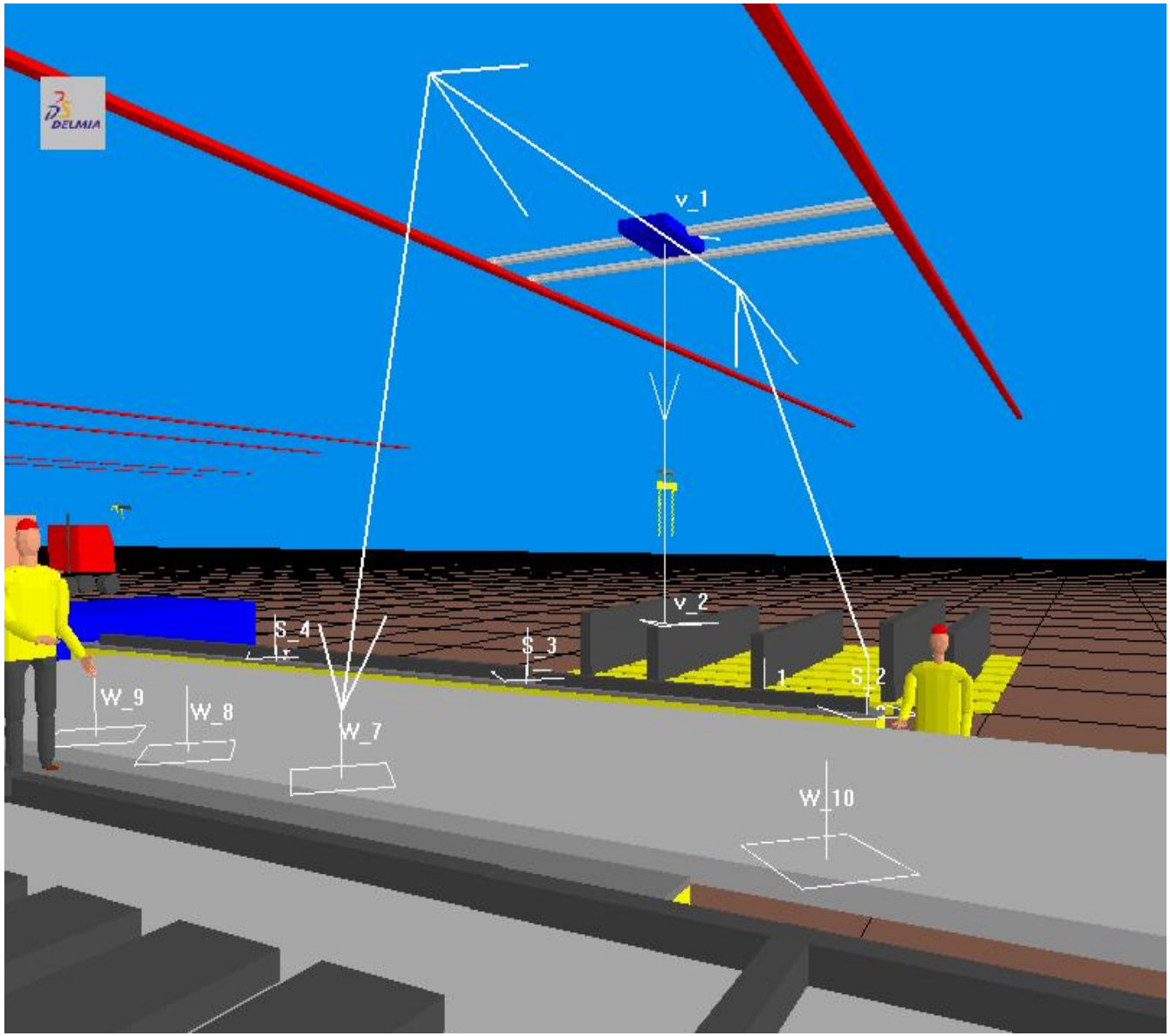
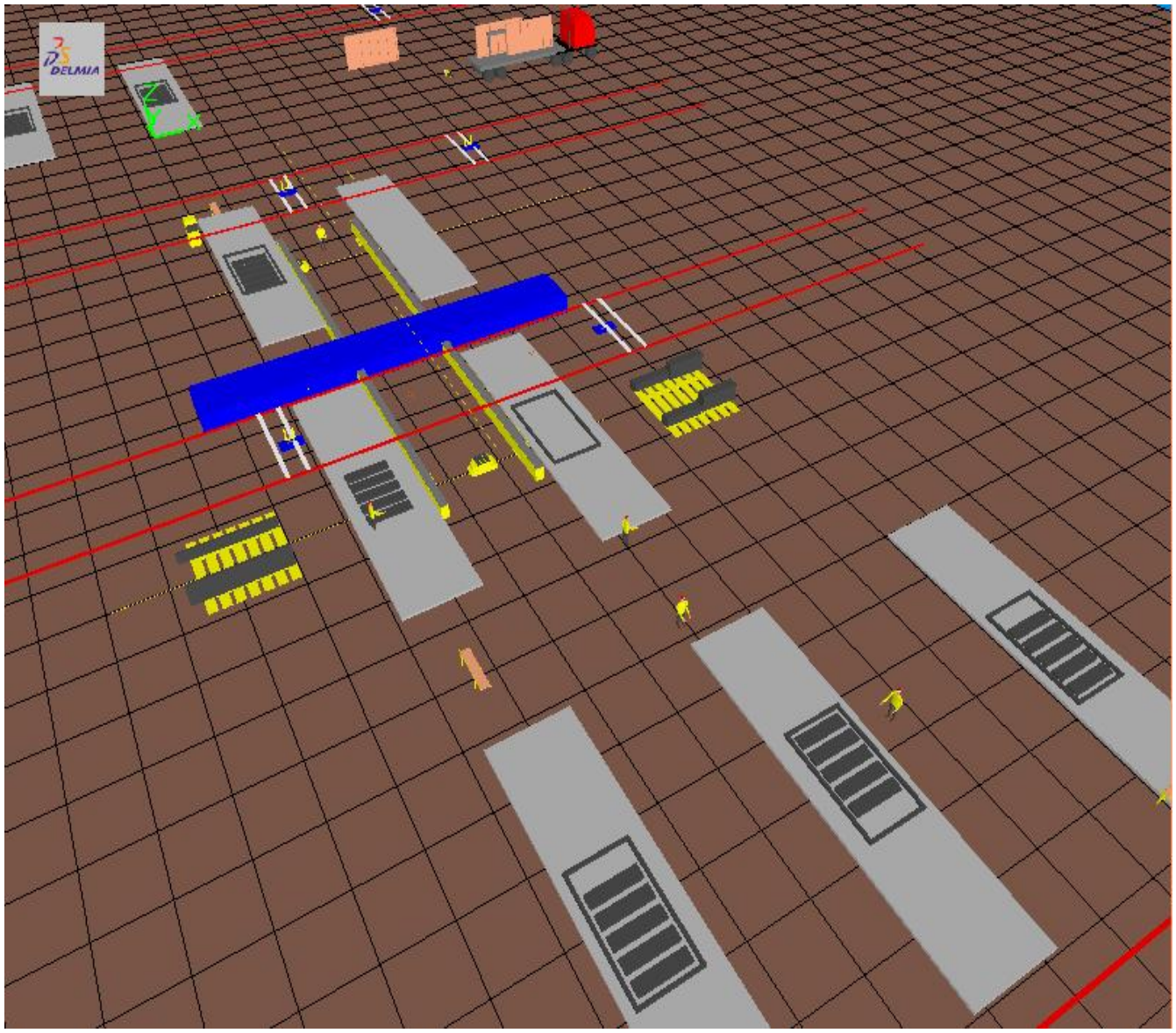

v_1
v_2
S_4
S_3
S_2
W_9
W_8
W_7
W_10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Early Results – what will we use them for

- Understanding information requirements
- Ergonomic analyses
- Optimal assembly sequences
- Consideration of assembly in design

Other Opportunities for Virtual Prototypes and Models

- Performance analysis – needs better understanding of building performance and performance models
- Reducing the fragmented approach to design/construction results in optimization of subsystems, but not of overall performance
- Understanding interactions between subsystems and predict effects on performance
- To increase performance of the whole
- This work has begun funded by US Department of Housing and Urban Development but many other efforts are underway internationally. eg Accurate in Australia

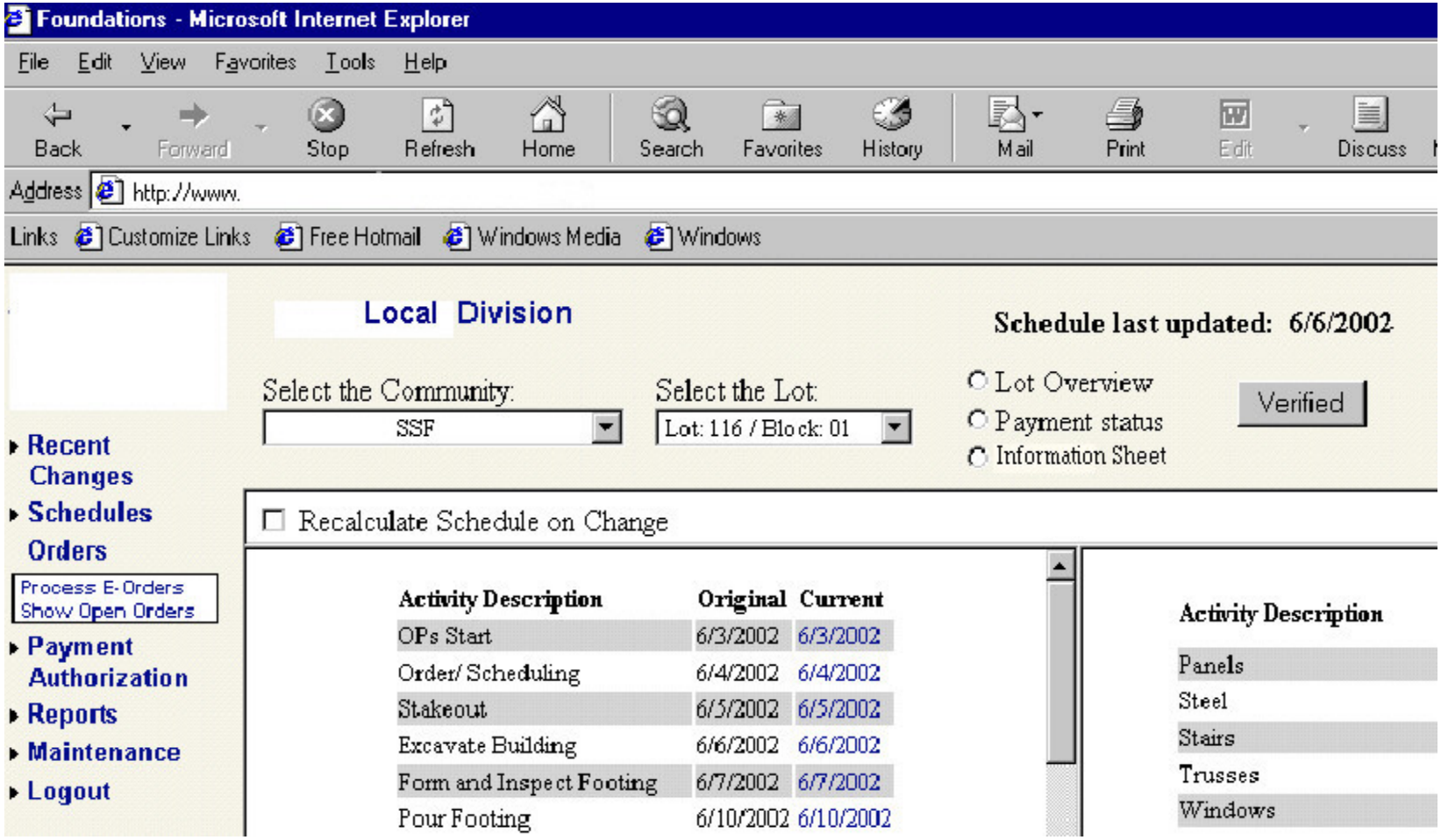
Internet Based Project Management

- Information integration as the key to construction efficiency
- Construction management has changed greatly with mobile phones, faxes and the internet
- This offers great possibilities for the future

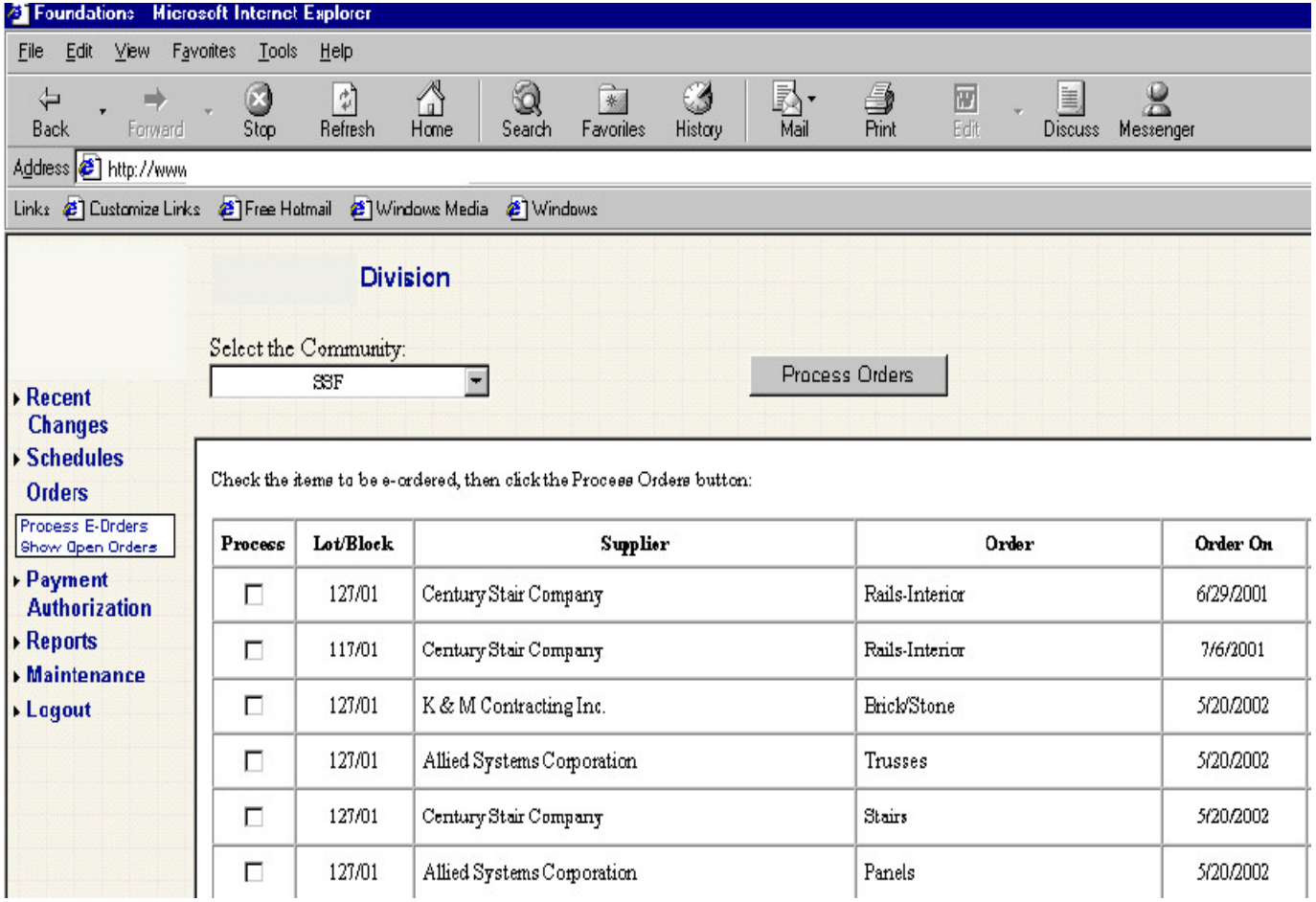
Web – Based Project Management

- Scheduling and updates - web based available all day, every day, change auto-filtered for each sub.

Web – Based Project Management



Web – based orders to suppliers



Process	Lot/Block	Supplier	Order	Order On
☐	127/01	Century Stair Company	Rails-Interior	6/29/2001
☐	117/01	Century Stair Company	Rails-Interior	7/6/2001
☐	127/01	K & M Contracting Inc.	Brick/Stone	5/20/2002
☐	127/01	Allied Systems Corporation	Trusses	5/20/2002
☐	127/01	Century Stair Company	Stairs	5/20/2002
☐	127/01	Allied Systems Corporation	Panels	5/20/2002

Conclusion

- We need to continue our focus on construction trade training and education – including regulation
- New prefabricated systems are a potential change that may occur they may offer better performance
- We can use overseas experience to inform our response to pressures in the industry
- We need to understand our industry better from process to social issues

Thank you